Special Report on the prevalence of Fevers in the Dinajpur District—By Leonard Rogers, M.D., M.R.C.P., F.R.C.S., B.S., I.M.S.

The present enquiry was ordered by the Government of Bengal to be carried out on account of the death-rate from "fevers" having risen to over 40 per thousand, a previously unknown maximum, the plan of work being drawn up by the Sanitary Commissioner. The lines of investigation suggested by this officer w ere the following:—Firstly, lists of those who had died during the previous year in certain areas or villages were to be obtained from the thana books, and then the villages were to be visited, the relatives of the deceased sought out, and enquiries made from them as to the duration and symptoms of the fatal illness, and a diagnosis to be thus arrived at whenever possible. Secondly, any fever cases met with were to be examined in order to ascertain their exact nature. Owing to the investigation having to be carried out during the latter half of the cold weather and early part of the hot season, which is just the season of minimal prevalence of fever, opportunities of using the latter and more accurate method of enquiry were unfortunately very scanty, but on the other hand the time was most favourable for the village enquiry, which has occupied the greater portion of my time, and, in spite of the necessarily imperfect character of the data obtainable, a good deal of valuable information has been collected, which will at least enable a more accurate estimate to be made of the relative frequency of the principal causes of death generally returned by the village chaukidars under the very elastic heading "fever" than has hitherto been possible. This portion of the enquiry will, therefore, first be dealt with.

Part I.— The Village Enquiry.

In accordance with the orders of the Sanitary Commissioner certain villages or groups of villages had to be selected for the enquiry. Unfortunately the only records obtainable of the death-rates of different areas related to whole thanas, and no separate figures were avilable of those of different circles, much less of the separate villages. The thana death-rates were, therefore, first examined, and it was noted that the

areas which returned the highest "fever" death-rates were the three northern thanas, while the two in the southern extreme of the district had much the lowest death-rates. The intermediate ones all had a fairly uniform and interemediate rate. It was therefore arranged to examine circles in each of the three northern very unhealthy areas, in the two southern comparatively healthy ones, and in two intermediate ones, one to the east of Dinajpur and one to the west (see map). The headquarters of the thanas were first visited and enquiries made as to any specially unhealthy parts made, which, however, seldom resulted in any definite information on that point being gained owing to the absence of mortality figures for small areas. The circles were, therefore, chosen to illustrate as far as possible different conditions. Thus to the east of the town of Dinajpur a circle was selected which was bounded on both sides and to the south by streams, one of which was of a specially stagnant and swampy nature. At Birganj to the north-west of the district one group of villages on a main stream to the north-east of the thana was chosen, and another well away from the river in a drier area to the north-west. In the extreme south a business, as opposed to an agricultural class of people were selected at Nitpur, as well as a village population on either side of it, but unfortunately the population of the town proved to be so "floating" a one that no relative of many of the deceased could be found to give any information as to their illnesses. Circles containing three to four thousand inhabitants were taken, and a list of the deaths in each village returned as "fever" was obtained from the thana, together with the name of their nearest relatives, who were then collected in the villages and questioned. The notes of each case were taken down in shorthand, a regular series of questions being put designed to cover the principal symptoms of the diseases which most commonly produce fever, supplementary ones being asked whenever necessary. As a rule the answers received were surprisingly clear, and in the great majority of the cases a very fair history was obtained. In one or two villages only was a tendency noticed to systematically answer every question in the negative without a moment's consideration, and these cases had to be omitted from the tables. An idea of the nature of the information obtained can best be conveyed by recording the notes of a few consecutive cases such as the following group :—

Thana, Thakagaon, village, Salanda.

No. 1. Female ; aged 57 ; died 11th February, 1903. Informant her son. Had suffered from several attacks of intermittent fever during the last two months accompanied with shivering fits The last fatal attack of fever was of a continued type and lasted about twelve days.

There was pain in the left side of the chest, cough and mucous expectoration. The spleen was not noticed to be enlarged. There was no swelling of the feet, and neither pain nor swelling in the joints. During the last three days the bowels were loose, about three motions a day being passed. Diagnosis: pneumonia: following chronic malarial fever.

No. 2. Male; aged 18; died on 3rd March, 1903. Informant his brother. He had suffered from repeated attacks of fever for about one year. The last attack was of a continued type of six days' duration. He suffered from much cough, with muco-purulent expectoration throughout the whole course of his illness, and had pain in the right side towards the end. The spleen was not noticed to be enlarged, and there was no swelling of the feet or joints and no diarrhœa, but he was much wasted. Diagnosis: phthisis.

No. 3. Male; aged 34; died 13th March, 1903. Informant his brother. Suffered from fever of eight days' duration, of continued type, accompanied by pain on both sides of the chest, much cough and much muco-purulent expectoration. There was no enlargement of the spleen, diarrhœa or swelling of the feet of joints. Diagnosis: broncho-pneumonia.

No. 4. Female; aged 80; died 16th March, 1903. Informant her son (aged 50). She is said to have had intermittent fever for fifteen days, some pain in the right side, but no cough or expectoration, and no splenic enlargement. There was no swelling of the feet or joints, but she suffered from diarrhœa several times a day during the last two days of her life, and had been in a feeble condition of health for some time previously. Diagnosis: diarrhœa.

No. 5. Male; aged 80 years; died 21st March, 1903. Informant his nephew. He had suffered from fever on and off for the last six months, the final attack lasting fifteen days. He had no pain on the chest and no enlargement of the spleen, but suffered much from cough all through his illness accompanied by mucous expectoration, but no blood. He had no diarrhœa or swelling of the feet or joints. He was not wasted, but his chest was large and barrel-shaped. Diagnosis: chronic bronchitis.

No. 6. Male; aged 49; died 22nd March, 1903. Informant his uncle. He had suffered from fever for one-and-a-half years of an intermittent character, the last attack lasting one month. He had pain on the right side, and throughout his whole illness he had a cough, accompanied by mucous expectoration, but no blood. His spleen was not enlarged, and he had no swelling of the feet or joints. At the end he had diarrhœa for the last five days. Diagnosis: phthisis.

No. 7. Male; aged 60; died 6th April, 1903. Informant his son. His last illness lasted fifteen days, during which he suffered from continued fever. He had no pain, cough, enlargement of the spleen, swelling of the feet or joints, but suffered during the whole time from looseness of the bowels which were moved about eight times a day for fifteen days, the motions being accompanied by the passage of blood and mucous. Diagnosis: dysentery.

The above will serve to give some idea of the kind of histories obtained. Over one thousand cases in all were enquired into, and similar tabulated shorthand notes taken down on the spot in pencil, and as a rule on the same evening they were inked in and an analysis made. The principal difficulty occurred in deciding under what heading to place complicated cases, such as a chronic malarial fever with terminal dysentery or pneumonia. When the final illness and death was clearly due to the complication after an interval of freedom from fever it was placed under the heading of the disease which actually produced death, but the malarial complication predisposing was also noted. In all a diagnosis was come to in just 1,000 cases, a number which could not have been noted with in anything like as full a manner as was done within a reasonable time without the use of shorthand. Before making up the tables every case was gone over again after the whole of the notes had been taken, and great care taken that the same system of diagnosis and classification was carried through the whole series, the advantages of the lengthy experience gained being brought to bear on the whole number. It will be most convenient to first deal with the percentages of deaths due to the principal diseases as derived from an analysis of the whole number, so as to gain an idea of the main causes of the mortality of the district and their relative frequency; and then the variations in their frequency in different circles in the district will be pointed out. Next the rates per thousand of population in each area of the main diseases will be given and the deductions to be drawn from them indicated. Lastly, any variation in different village groups in each circle which appear to throw any light on the subject will be discussed. In this way we shall work backwards from the more accurate data based on the largest figures to the less certain ones supported by smaller series of cases, the former giving a standard of comparison for the latter.

Analysis of 1,000 Deaths returned as "Fever" in the Dinajpur District.

Before going on to the various tables in which I have analysed the

data collected, the whole of the cases must first be summarised in the following form which the Sanitary Commissioner has asked for :—

TABLE I.

Total number of deaths from "fever"	1,104
Number of deaths from malarial fevers*	318
Number of deaths from non-malarial fevers	368
Number of deaths wrongly reported under "fever" ...	314
Doubtful or unascertained	104

It appears from this table that nearly one-third of the cases returned under the head of "Fever," which includes 90 per cent. of all deaths in the Dinajpur District, are incorrectly classed as such, while of the two-thirds correctly returned less than half are due to malarial fevers, including chronic fevers, some of which are probably due to unclassified fevers while a few others may be cases of various chronic diseases, the histories of which were not sufficient to enable them to be accurately diagnosed.

In the following table the 1,000 cases which were diagnosed are classified according to the most frequent causes of death, the percentages from each cause for the different circles examined being shown, while in the last column the percentages of the total number of deaths from each cause is entered :—

TABLE II.

	Dinajpur.	Balurghat.	Porsa.	Churaman.	Birganj.	Ranisankail.	Thakurgaon.	Percentage of total cases diagnosed.
Thana fever rate per thousand	44·06	29·99	29·05	38·93	43·43	47·21	41·67	...
Malarial, acute	17·5	14·7	16·25	11·3	14·58	5·3	12·0	13·3
Ditto chronic	24·0	16·0	18·75	18·6	16·7	17·3	15·5	18·5
Pneumonia ...	18·6	21·3	11·25	11·3	27·7	22·0	28·0	21·7
Phthisis ...	5·5	6·7	10·0	8·0	8·3	13·3	10·0	9·0
Bronchitis ...	3·8	2·0	1·25	1·6	1·4	1·3	3·0	2·3
Diarrhœa ...	4·4	10·0	11·25	12·1	10·4	13·3	9·0	10·2
Dysentry ...	3·8	7·3	3·75	11·3	5·5	7·3	3·5	6·1
Enteric ...	...	2·0	3·75	1·6	1·4	0·8	3·5	1·8
Born feeble ...	15·8	10·7	10·9	10·5	3·5	11·3	8·0	10·4
Other causes ...	6·6	8·7	5·0	8·8	7·6	4·8	5·0	6·7
Not diagnosed ...	...	0·6	8·75	4·8	3·9	3·3	2·5	...
Total cases ...	183	150	80	124	144	150	200	100·0

* Chronic cases many of which were doubtless due to the parasite recently described by Majors Leishman and Donovan are included under this heading.

This table presents several points of interest. In the first place it brings out the fact that all varieties of diseases are returned by the village chaukidar as "fever," a point which will be further illustrated when I come to discuss the cases classed above under "Other causes." The most striking evidence in this connection is the fact that although in the figures for the Dinajpur district for 1902 only 0·07 per thousand deaths were recorded under the head of "Dysentery and Diarrhœa," yet we find that among the cases returned as "fever" in the circles investigated no less than 16·3 per cent. belonged to this class, while in many other cases diarrhœa and dysentery were present as complications of malaria, phthisis and other diseases. The total death-rate of the district from fevers having been 37 per thousand, it is evident that the death-rate under dysentery and diarrhœa should have been about 4·5 per thousand, instead of 0·07, or in other words, only one case out of 63 dying of these bowel-complaints were correctly returned. Of course both dysentery and diarrhœa are often accompanied by fever, which the village chaukidar may well consider to be the primary cause of death, but the fact remains that the figures yearly published in the voluminous tables of the Sanitary Commissioner's annual report, the yearly variations of which have to be carefully explained, are, to say the least of it, grotesquely inaccurate and necessarily so under the present conditions of reporting. These cases of bowel-complaints, together with the deaths classed as "born feeble" (a term which will be explained presently) and many of those under "Other causes," together make up almost one-third of the total, all of which have been incorrectly returned under the head of "fever."

Secondly, the proportions of the different diseases correctly reported under the head of "fever" are most instructive. Thus we find pneumonia accounted for the largest proportion of deaths, namely 21·7 per cent., then came "Chronic malaria" 18·5 per cent., thirdly Acute malaria 13·3 per cent., and not far behind Phthisis no less than 9 per cent., while Bronchitis and Enteric accounted for the greater part of the remaining cases. It will be instructive to compare these figures with those I obtained for another purpose some time ago by analysing 950 consecutive *post-mortems* on cases from the medical wards of the Medical College Hospital, in order to ascertain the most frequent causes of death likely to be returned under "fever." At the same time the diagnosis made in fatal cases occurring in the Dinajpur hospital during the last two years may be given. These figures are shown in table III, but in comparing them with the results of the Dinajpur village enquiry certain points must be carefully borne in mind. The most important of these is the question of the ages of the

patients in the different series, for in the village death-rates all children are included, while at the Medical College Hospital but few children are admitted, while *post-mortems* are, practically speaking, never obtained on any who may die in the hospital. Similarly children are very rarely admitted to the Dinajpur hospital and infants never. This fact accounts for the comparatively small number of cases of acute malaria, diarrhœa, and to a less extent of pneumonia in the hospital figures. Due allowance being made for these differences, the figures are not without instruction :—

TABLE III.

	Deaths in the Dinajpur Hospital. Per. cent.	Calcutta Medical College *post-mortem.* Per cent.
Malaria, acute, and remittents	26·4	3·2
Ditto chronic	13·6	5·6
Pneumonia	10·0	11·0
Phthisis	5·0	16·9
Serous inflammations	6·9	...
Enteric	0·7	0·4
Other fevers	2·9	8·6
Diarrhœa	5·0	...
Dysentery	19·3	...
Other causes	10·2	54·3*

In the Dinajpur hospital many of the cases returned as remittents occurred in the cold weather months, and were no doubt due to pneumonia, but still, allowing for this, acute malarial fevers were certainly much more common than in Calcutta, as might have been expected. Some of these cases were probably of a chronic type, making the figure under that head lower than it should be. Pneumonia was equally prevalent in both hospitals although this figure for Dinajpur under Dinajpur under-estimates the real number, for during the time I was in the district this disease was the most frequent cause of admission and death from continued or remittent fever.

Phthisis is of great importance, as in the Calcutta hospital it is by far the most frequent cause of death accompanied by marked fever during the illness, having constituted almost one-third of such cases. The high figure of 9 per cent. obtained in the village enquiry probably underestimates rather than exaggerates the death-rate from this cause, while the 5 per cent. of cases dying in the Dinajpur hospital is probably too low, owing to some cases being overlooked by the Hospital Assistant.

* Includes diarrhœa and dysentery cases.

We have, then, clear evidence that phthisis plays a very important part in the death-rate of Bengal villages as well as of the towns, and the disease was especially prevalent in the larger villages with more numerous substantial houses with impermeable walls, in which the people delight to shut themselves up in at night as closely as possible in the cold weather months. Several well-marked cases of the disease were seen in the villages, while it will be seen from tables II and VI that the disease was most prevalent in the northern and coldest thanas. It must, however, be remembered that malarial fever plays a most important predisposing part in the production of pulmonary tuberculosis, so that the high rate in the northern parts of the district may be partly due to their malarious character. This predisposition is well seen in two different class of cases,—firstly, in the case of adolescents, in which phthisis frequently makes its first appearance as a sequel to chronic malarial fever, and, secondly, in middle-aged people in whom old and latent tubercle of the lungs becomes fatally active as a result of the resisting powers being broken down by malarious attacks, as I have often seen in the Medical College *post-mortem* room.

The only other form of fever which requires comment here is probably enteric. The correctness of the diagnosis of these cases from the history of the illnesses obtained is open to greater question than in most of the other forms of fever deal with, and in no case was a clear history of hæmorrhage from the bowel obtained. Cases were, however, met with in every circle visited of two to four weeks' continued fever without signs of pneumonia or other cause, some of which I feel sure were enteric cases. The figures must only be taken as indicating that the disease does occur in the villages in small numbers, while this is supported by the fact that one case was seen in the jail recently, and the diagnosis confirmed *post-mortem*, and another case was diagnosed in the hospital at Dinajpur about a year ago. That the disease is common enough in Calcutta among natives I demonstrated[1] some three years ago, while I have since that time seen cases in Chota Nagpur, and obtained positive serum reactions for typhoid in the blood of several cases sent from that part of Bengal, and have no doubt it occurs not very rarely in the province. I have not, however, obtained any evidence during this enquiry of its being at all a common cause of death in the Dinajpur district, so am inclined to think that the figure of 1·8 per cent. of fever deaths shown in table II is approximately correct, although probably somewhat under the mark. It was not found to be especially prevalent among children.

[1] Typhoid as a common continued fever of natives.—*Indian Medical Gazette*, January 1902.

Lastly, the term "born feeble" has been used to denote a very common class in which infants die during the first few days of life, being invariably returned under the head of "fever" by the bewildered chaukidars. These cases form no less than 10 per cent. of the total mortality thus returned, and account for a great part of the very high infant mortality. In only a small proportion of these could a history of premature birth be obtained, but as the informants were nearly invariably men this proportion was probably too low. In a larger number it was found on enquiry that the infant was small and thin at birth, although syphilis does not appear to be nearly as common in the villages as in the town. An attempt was made to ascertain if this mortality was due to immaturity of the mothers or over-frequent child-bearing, but the husbands nearly always professed complete ignorance of their wives' ages, or stated that it was from twenty to thirty even when they had but one child. One important fact was, however, ascertained, namely, that in a large proportion of the cases the mothers had suffered from malarial fevers for some time in the last month or so before delivery, while it will be seen from table IV that the majority of these feeble infants were born during the height of the malarial fever season from August to December. These facts point to the high infant mortality being largely due to repeated malaria during pregnancy causing the birth of many very feeble infants, which succumb in a few days after their entrance into conditions which they are unfitted to withstand. The other chief cause of the high infant mortality is diarrhœa, which is most prevalent during the hot weather months. In several of these cases the mother had died either during delivery or from puerperal septicæmia, the infant being fed on cow's milk. As may easily be imagined its chance of survival in a native village under such conditions is small. Several of the early infant deaths occurred in the case of twins, while males died as often as females.

"Other causes" include two classes of cases, diseases rightly returned under fever and those of which fever is not an essential symptom. Among the former are puerperal fever 10 cases, or 1 per cent. of fever deaths; peritonitis 5; meningitis 3; rheumatic fever (?) 1; and lymphangitis 1, making a total of 20, or 2 per cent. The second class include dropsy 19 cases; child-birth 5, or 0·5 per cent.; tetanus neonitorum 5; old age 5; malignant tumours 3; small-pox 1, cholera 3; and one each of epilepsy, measles, liver abscess, asthma, bad feeding in an infant, snake-bite, syphilis, epistaxis hæmatemisis and drowning, all of which had been returned under the head of "fever." Many of these mistakes show obvious carelessness on the part of the chaukidars, but many of the more common errors would appear to be due to want of some small

degree of instruction and control. Thus some thanas show no cases at all returned under the head of diarrhœa and dysentery, while only 70 deaths were returned under this head in the whole district in 1903. The numbers under "Other diseases" are always very much below the mark, only 295 cases having been shown in 1903. Whether the slight improvement which might be expected to result in from some elementary instructions being issued to the chaukidars is worth the trouble of undertaking must be left to the Sanitary Commissioner to decide, for in no case can anything approaching a reasonable degree of accuracy be expected from the present agency, while it is not easy to see how any other agency could be employed except at a prohibitive cost. The question whether many deaths escape registration my enquiry was not best fitted to ascertain, but on several occasions after going through the list of deaths returned I enquired for other deaths, but, as a rule, those which were mentioned by the villagers belonged to other years, and I came across very few deaths which had not been reported. The introduction of the duffadari system several years ago appears to have produced a considerable improvement in this respect, and as far as I can make out the total death-rates are now fairly accurate, although possibly somewhat below the mark in the southernmost thanas.

Monthly Distribution and Age Incidence of the Principal Diseases.

The age and date of death of each case was noted, and the analysis of these data has presented some points of interest and importance, which can best be shown in tables illustrating these data in regard to the chief causes of deaths returned as "fever."

Table IV.—Monthly Incidence of Diseases.

	Malaria, acute.	Malaria, chronic.	Pneumonia.	Phthisis.	Bronchitis.	Diarrhœa.	Dysentery.	Enteric.	Born feeble.
January ...	...	16	27	8	4	10	2	...	5
February ...	...	11	27	6	...	8	4	1	10
March ...	...	20	8	10	4	9	4	6	8
April ...	7	17	19	5	2	12	11	2	11
May ...	2	11	17	8	2	10	1	2	2
June ...	9	13	16	7	1	6	5	1	3
July ...	17	14	10	3	1	6	2	1	2
August ...	17	13	8	2	2	5	8	...	7
September ...	19	11	6	6	...	5	2	...	9
October ...	22	15	20	4	2	5	4	...	13
November ...	24	20	28	14	2	17	3	2	16
December ...	16	24	31	17	3	9	15	3	18
Total ...	133	185	217	90	23	102	61	18	104

The seasonal distribution of the different diseases shown in this table are just what might have been expected, and thus indirectly confirm the general accuracy of the diagnosis arrived at. The most striking figures are those classed as acute malaria, the diagnosis of which was largely a matter of exclusion of other likely kinds of fever, and the fact that the very great majority of the cases occur in the height of the malarial season strongly supports the substantial accuracy of the data obtained, and also show that the time of the enquiries was the minimum malaria fever season, a fact which is in agreement with the returns of cases treated at the dispensaries of the district. Again, in the case of pneumonia the majority of the cases occur in the cold weather months, when the temperature falls to 30°F., the early mornings being both cold and misty. The cases classed as chronic malaria are more uniformly distributed, yet the largest numbers occur in the latter part of the malarial season, while an examination of the duration of these cases shows that the great majority of deaths from chronic fevers of from one to three months' duration occurred during the late autumn and early cold weather months, being thus doubtless mostly of malarial origin; while on the other hand most of the cases of very long duration, namely, six months or a year and more, died during the months of from March to July and most frequently in the hot weather season. Most of these latter were probably cases of the cachexial type of fever in which Leishman-Donovans bodies are found.

The prevalence of the cases classed as enteric in the dry months in the greatest numbers, and the nearly complete absence of them in the wet malarial season is also in accordance with the distribution of enteric fever in Calcutta, as I have shown in a previous paper.[1]

The great frequency of deaths in infants of a few days old during the malarial autumnal months has already been pointed out and discussed. Diarrhœa cases were most frequent in the hot season among children of under one year.

In the table on the next page, again the most striking and important figures relate to acute malaria, for it appears that three-quarters of the fatal cases under this heading occurred in children under ten years of age; and as it is now known that the infection of malaria is also spread mainly through children, it is clear that any measure which will appreciably lower the amount of malaria in children will have a most marked effect in reducing the death-rate from this disease. In the case of chronic malaria, too, a large proportion of the shorter and most definitely malarial cases also occurred among the children, while the majority of cases

[1] The differentiation of the continued and remittent fevers of the tropics by the blood changes. Trans. of the *Medical Chir. Soc.*, 1903 and *Lancet*, Volume 1, 1903.

TABLE V.—AGE INCIDENCE OF THE PRINCIPAL DISEASES.

Year.	Under 1.	1—5.	5—10.	10—15.	15—20.	20—30.	30—40.	40—50.	50—60.	Over 60.	TOTAL.
Acute malaria ...	21	59	21	7	7	5	3	6	3	1	133
Chronic malaria ...	2	30	20	12	11	28	23	20	11	28	185
Pneumonia ...	16	34	23	19	21	21	20	19	11	33	217
Phthisis ...	...	...	...	4	6	21	22	20	9	8	90
Bronchitis ...	...	...	...	...	...	...	1	...	2	20	23
Diarrhœa ...	41	23	4	3	2	5	6	3	2	13	102
Dysentery ...	8	9	5	3	2	8	10	4	6	6	61
Enteric ...	...	1	...	4	1	5	6	...	1	...	18

among adults were of a chronic nature, that is of a month or more in duration.

In the case of pneumonia it appears that nearly one-half of the cases occurred in children under 15 years old, who are scarcely ever admitted to hospitals, while the next most common age is over 60, generally in the form of broncho-pneumonia. Phthisis, on the other hand, is met with chiefly in young and middle-aged adults and bronchitis in old people.

Diarrhœa was by far the most common in infants under one year of age, more especially in the hot weather months, and next in children between one and five years of age, and in very old people, between 60 and 90 years. Dysentery was more evenly distributed, children and middle-aged adults chiefly suffering. Enteric was most prevalent between the ages of 10 and 40, and was not frequently met with in young children.

The figures given in table II, showing the relative proportion of deaths from different diseases in each circle, show a considerable degree of uniformity, but the exact percentage of different diseases in any one class will necessarily be dependent on those in the others. For example, in the case of the Thakurgaon district in the extreme north pneumonia is particularly prevalent, leaving a smaller number of cases to be distributed among the other causes of death. For this reason only general deductions can be drawn from these figures such as the larger proportion of cases of pneumonia and phthisis in the northern colder circles, as already pointed out. For the comparison of the degree of

healthiness of the different parts of the district the death-rates per thousand of population must be examined.

Death-rates per thousand in each Circle from the Principal Diseases.

The distribution in the district of the different groups of villages in which the enquiries were made has already been briefly indicated, but some further remarks on the topographical conditions of these areas must be made. At this the driest time of the year it is very difficult to find any definite differences in the general surroundings of the villages in different circles, all resembling each other exceedingly closely. The whole district is one huge collection of rice-fields together with areas where jute is grown, and here and there patches of jungle, especially in the northern portion of the district. Numerous shallow half-dried up streams traverse the district from north to south, mostly in wide sandy beds, while among the rice-fields here and there small swamps of shallow weed-grown water still remain in the cold season. Tanks are fairly numerous and, in many places, are situated at a distance of several hundred yards from the villages, so that, their banks not being the nearest and most convenient latrine, the water of many of them appears to be good. There are also numerous wells in all parts of the district except the south, where the water-level is much lower than elsewhere, and wells therefore much more difficult to construct. In fact, the higher the ground water-level the greater the number of village wells. The water-supply, however, of neighbouring villages, whose general surroundings were similar, differed so little that no definite instances of variations in the death-rates, which could be attributed with any reason to their water-supply, were met with. In a previous enquiry,[1] which I carried out in the Bogra district, I found a very definite relationship between the lowness of the ground water-level in the dry season and the lowness of the spleen-rate, while the Malaria Commission have recently shown that there is a definite relationship between the spleen-rate and the proportion of children infected by the malarial parasites, or as, they call it, the "endemic index." This is a most important fact, as in a single-handed enquiry of the comprehensive nature required in the present instance it was impossible to attempt to work out the "endemic index" in all the areas visited, while an attempt to do so on a limited scale in the Bogra enquiry showed that in the minimal fever season of the late cold weather it does not give results proportional to the labour involved in carrying it out. In the present instance, therefore, I examined as many children between the ages of 2 and 10 as I could in each circle, and also carefully took measurements of the ground

[1] Report on the effect of the silting up of the Karatoya river on health of the Bogra district, 1901.

water-level in the wells. These figures are embodied in the following table of the death-rates per thousand in each circle from the main diseases :—

TABLE VI.

	1	2	3	4	5	6	7
	Dinajpur.	Balughat.	Parsa.	Churaman.	Birganj.	Ranisankail.	Thakurgaon.
1. Position in district	C.	S.-E	S.-W.	W.	N.-E.	N.-W.	N.
2. Ground water-level in feet	8-10	16-20	33	15	9-17	5-12	12
3. Spleen-rate per cent.	54·3	56·7	28·3	29·3	72·8	83·2	95·0
4. Thana birth-rate	42·5	38·87	37 62	45·38	40·44	39·96	37·75
5. „ total death-rate	49·28	34·78	31·33	41·60	44·93	48·52	43·56
6. „ fever death-rate	44·06	29·99	29 05	38 93	43·43	47·21	41·67
7. Population of circle	3,886	4,253	3,848	3,307	3,355	3,400	4,459
8. Fever death of circle	187	164	109	132	150	157	205
9. Ratio per 1,000	48·06	36·33	28·62	39 88	44·70	46·20	45·96
10. „ „ „ of acute malaria	8·19	5 2	3·41	4·23	6·26	2·35	5·38
11. „ „ „ of chronic malaria	11·31	5 4	3 94	6·95	7·15	7·35	6 94
12. „ „ „ of pneumonia	8·70	7·52	2·36	4 23	11 02	9·69	12·55
13. „ „ „ of phthisis	2·57	2·35	2·10	3 02	3·57	5·88	4·48
14. „ „ „ of bronchitis	2·05	0·7	0·26	0·6	0 59	0·59	1·34
15. „ „ „ of diarrhœa	2·05	3 5	2·36	4·53	4·47	5·88	4·03
16. „ „ „ of dysentery	1·80	2 6	0·79	4·23	2 38	3·23	1·57
17. „ „ „ of enteric	...	0·7	0·79	0 6	0·59	0·59	1·57
18. „ „ „ of "born feeble"	7·45	3·7	2·10	3·93	1·49	4 96	3·59
19. „ „ „ of other causes	2·05	3·4	1·05	3·33	3·28	2·35	2·24
20. „ „ „ of not diagnosed	1 03	3 5	9·46	4·23	3·87	3·53	2·24
21. Total malaria including complicated cases ...	21 55	11·3	8·40	12·38	15 51	16·10	16·82

A comparison of the second, third and the sixth lines of the table shows a remarkable relationship between a high ground water-level and high spleen-rates and fever mortality of the thanas and *vice versâ*. Thus at Porsa the ground water-level was 33 feet down, and the spleen-rate was only 28·3, the lowest met with, while the fever death-rate of 29·05 per thousand was also the lowest of all the thanas. Exactly the reverse holds good of the Ranisankil circle, in which the highest ground water-level coincides with the highest spleen and fever-rates. Similarly, Dinajpur, Birganj, and Thakurgaon thanas show high ground water-levels and spleen and fever rates, while those of Balughat and Churaman have lower rates approaching those of Parsa. The Dinajpur spleen-rate was not as high as might have been expected, but the number of children examined in that circle was small. Turning next to line 9, which shows the fever death-rate per thousand in the circles examined, we find a remarkably close relationship between the death-rates of these small circles and those of the thanas in which they are situated (line 6), clearly showing that the number of deaths enquired into in each circle were sufficient for the purpose of getting fairly accurate

figures. An examination of the death-rates per thousand from the principal diseases reveals the fact that in the unhealthy thanas (1, 5, 6, and 7) the cases returned under acute and chronic fever and under pneumonia are especially high as compared with the less unhealthy areas (2, 3, and 4): further the highest rate for children dying within a few days of birth are also found in thanas (1 and 6), that is just the two which have the highest fever death-rates. The highest rates for phthisis are also met with in the unhealthy northern thanas 6 and 7. The rates for bowel-complaints are irregularly distributed in this respect. In line 21 the figures of the total death-rate from cases classed as malarial fever, including those dying of complications, such as pneumonia, dysentery and diarrhœa, are given, and they bring out clearly the fact that the principal cause of the differences in the death-rates of the unhealthy and less unhealthy circles is mainly due to the greater mortality from malarious diseases in the former class—a point of the utmost practical importance, as it is among these cases that there is the best chance of lowering the mortality and saving lives by proper sanitary and prophylactic measures. This is in fact one of the most important conclusions to be derived from the analysis of the tables, based on figures which have been collected with great care and trouble, and which are at least very much more accurate than the ordinary statistical data available.

The relationship to the ground water-levels of the health of the different areas shows that these local variations are dependent on the physical characters of the country, which cannot be altered save by the slow operations of nature in raising a deltaic tract or by the more rapid action of severe earthquakes, such as that of 1897, which is said to have improved the health of the Rangpur district, probably by slightly raising the level of the country and thus allowing of better surface drainage and more rapid drying up of the soil at the end of the rainy season.

The Seasonal Influence of Variation in the Rainfall.

In this connection it will be convenient to refer to the seasonal conditions which influence the mortality from fevers in different years. It is unnecessary to go into detail on this point, as the results of a close study of the monthly rainfall of different parts of the district and the fever death-rates for the last ten years have only confirmed the very close relationship between a marked deficiency of the rainfall and a high death-rate from fevers, which I pointed out in 1897 in my report on Kala-azar[1] to have been characteristic of the Rangpur and Dinajpur

[1] Report on Kala-azar, 1893.

districts, for the last thirty years, and which I showed in my report on the health of the neighbouring Bogra district[1] also holds true of that area. In Dinajpur there was one marked exception to this rule for the rainfall was heavy in 1902, and the fever death-rate also high, but on examining the monthly figures it appeared that, although the total fall was high, the rains stopped earlier than usual, the amount in the latter part of the rainy season being deficient. The explanation of the relationship is simple enough, as when the rains are deficient and especially when they are so in the latter part of the season, then the time during which the country is drying up, and innumerable pools suitable for the breeding of mosquitoes are present, is prolonged, and the fever season, which is autumnal in these parts, begins early, and also as a rule continues late, the total death-rate being considerably enhanced. On the other hand, when the rains are steady and prolonged, these low-lying parts are mostly flooded and the mosquito larvæ are carried away. In support of this supposition I may cite the case of the floods in Calcutta in 1900, during which year I was making regular observations on the breeding places of anopheles in a suburb of Calcutta,[2] and the only time I failed to find any was soon after the floods. On the other hand, in high ground, such as Chota Nagpur, the fever season is at the height of the rains and follows the rise and fall of the ground water-level, malarial cases rapidly decreasing at the end of the rains owing to the quick subsidence of the ground water-level, as I showed in the case of Ranchi in 1896.[3] These seasonal variations are also beyond control, but a knowledge of them will not only allow the variations in the incidence of malaria to be easily understood in different districts, but the increases of the fever-rate may be confidently predicted as soon as the character of the monsoon has fully declared itself and measures taken by the medical authorities to meet the coming rise, while a decrease may also be forseen on the onset of a favourable season, and needless alarm of a recurrence of the high fever-rate may be allayed.

Birth Rates.

The Sanitary Commissioner has also asked for information on the relationship of the birth and death-rates. In 1902 the high death-rate was accompanied by a high birth-rate, that of the Dinajpur district

[1] Report on the effect of the silting up of the Karatoya river on the health of the Bogra district, 1901.

[2] The seasonal prevalence of anopheles and malarial fever in Lower Bengal and the practical application of the mosquito theory. *Journal of Hygiene*, October 1901.

[3] *Indian Medical Gazette*, February 1896.

having been 49 per thousand, and it has been pointed out that this is an unusual state of affairs. In line 4 of table VI are shown the birth-rates of the thanas in which I worked, and it will be seen that they are very much lower than those of the previous year. The explanation seems to be simply that as the highest death-rate due to fevers take place in the autumn, its effect in reducing the birth-rate will not be evident until the figures of the succeeding year are available, so that the lower birth-rate of 1903, corresponds with the high death-rate of 1902, as might have been expected. The large number of infants which die within a few days of death in the malarial season, their mothers having suffered from malaria before delivery, which has been already pointed out, also go to swell both the birth and death-rates of the Dinajpur district and partially account for the relatively high birth-rate. No definite relationship between the birth and death-rates of the different thanas can be made out from the figures given in table II, the birth-rates not having varied greatly in different parts of the district. The fact that both the birth and the death-rates are lowest in the two southern thanas may possibly be due to less efficient registration in that part of the district. The rates for all the villages visited have also been obtained for me by the District Superintendent of Police, Mr. F. L. Peters (to whom I am greatly indebted for all the trouble he has taken over my enquiry), but the figures show such extreme variations that it is clear that the populations of individual villages are too small for such a study to be of any value. Taking several villages together I find that the birth-rates were unusually low in most of the villages of the very unhealthy Ranisankail circle, where they averaged only about 30 per thousand, but more than that cannot be said.

Variations in the Mortality from Fevers in Individual Villages.

Next we have to consider the variations in the surroundings of different villages in relationship to the fever mortalities in them. Here we have to be specially cautious in drawing conclusions for several reasons. In the first place the villages are mostly very small, containing two or three hundred inhabitants only, so that small and possibly accidental variations in the number of deaths in a single year will make great differences in the rate per thousand of population. In the second place the subdivision of a circle into different villages for the purposes of mortality returns in this part of Bengal is a very artifical one, for villages in the sense of a collection of considerable number of houses close together are rarely met with, each so-called village really consisting of a number of scattered homesteads dotted at irregular intervals over a considerable area, which may amount to one or more square miles, so that the

relationship of different parts of a village to such a source of mosquitos as a small stream may differ widely. Further, as already pointed out, the conditions in the cold dry weather give but a faint and totally inadequate idea of the surroundings in the rainy fever season, as will be further illustrated in the section on mosquitos. Nevertheless in a few instances there seemed to be a definite relationship between certain conditions and the fever death-rate which are worth mentioning. Thus the Dinajpur circle comprised an area between two streams, one of which was a clean sandy river bed with a good flow, while the other was a stagnant weed covered and very sluggish one. Two villages on the banks of the latter had a fever death-rate of 81·8 per thousand, the highest rate met with during the whole enquiry. The other villages did not show such marked variations, but the death-rate of the whole area was very high, as was the water-level and the malarial rate. In short, it was a typical example of a waterlogged area in a "dying river" district.

Next we may take the Birganj circle, which furnished an instructive example. As already mentioned, the villages in this circle were chosen partly on a good river and partly several miles from it in an area quite dried up at the time of my visit. Nevertheless, the latter dry area showed a death-rate of 54·3 per thousand against one of 41·1 in a group of villages near the river and of 34·7 in a large village close to the river, but on higher ground with a water-level 17 feet down. The explanation of this difference was revealed when it was found that the dry area had the high ground water-level of 9 feet. It was therefore less well drained than the higher areas near the stream, and the floods of the rainy season would be longer in subsiding at the end of the year, and would thus form favourable mosquito-breeding grounds for a longer time. In the Thakurgaon circle there were four large villages of scattered hamlets all under very similar conditions and with about the same ground water-level (12 feet), and here the death-rates varied very little, all being between 40 and 50 per thousand. In Ranisankail itself the ground water was $12\frac{1}{2}$ feet down and the spleen-rate was 62·7 per cent., while the fever death-rate was 45·5 per thousand. In the villages to the north and south the spleen-rate was 98 per cent. and the ground water-level only from 5 to 11 feet down, while the fever death-rate was 74·3 per thousand, a very high figure. Here once more we find a relationship between a high ground water-level and a high spleen and fever rate. It was here that numerous cases of chronic fever with very large spleens were met with, the nature of which will be discussed in the second part of this report. They are precisely those cases which have always been known as "Malarial Cachexia" and which are responsible

for much of the death-rate returned as chronic fevers in my tables, although some of them fall under the head of pneumonia and dysentery, as these diseases often attack people debilitated by prolonged fever and prove the actual cause of their deaths.

The above four circles are those with the highest fever death-rates and the uniformity with which they show a marked relationship between a high ground water-level and high spleen and fever death-rates, a relationship which I have repeatedly pointed out in previous reports and papers,[1] is the most striking and important point brought out by this part of the inquiry.

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PART II.—THE NATURE AND ETIOLOGY AND PROPHYLAXIS OF THE FEVERS IN DINAJPUR.

The Varieties of Fever met with.

It has already been mentioned in the first part of this report that the enquiry was carried out in the minimal fever season, and that the village enquiry occupied the major part of my time. Nevertheless, a few cases of fever were met with attending the Dinajpur dispensary, the blood of which was examined for malarial parasites, while on two occasions a number of chronic fevers in the most feverish part of the district were examined by means of spleen puncture for the recently described parasite-like bodies found last year in chronic fevers by Leishman and Donovan, and more recently in a case from Sylhet by Manson and Low.

Firstly, with regard to the kinds of malaria met with, the commonest variety was the malignant tertian form just as it is in Calcutta and most parts of India. One case of benign tertian was also found in Dinajpur. During the village enquiry a history of quartan fever was obtained in a number of cases in the circle a few miles to the east of the town, and these cases were usually of a chronic nature, terminating fatally after several months of fever. During my last visit to Ranisankail a patient came to the hospital with a history of fever of the quartan type, and having suffered from an attack two days before. An examination of his blood showed typical quartan parasites, some just beginning to sporulate, which would correspond with his statement. These cases are probably much more common in the rainy season, and are of interest in connection with the finding of A. Listoni in the district to be mentioned presently, for in the Duars the Malarial Commisson found quartan fever to be the commonest type and to be also associated with the same species of anopheles. All three varieties of malaria were thus met with

[1] The relationship of the level of the ground water-level to the incidence and seasonal distribution of malarial fevers in India. *Lancet*, March 12th, 1898.

in the district even in the dry season, but it is not possible to deduce accurately the relative prevalence of each from the few cases found at this time of the year.

A more important question to solve was whether the Leishman-Donovan bodies could be found in chronic fevers in this district, and, if so, the frequency of their prevalence and how to differentiate from ordinary chronic malaria. Dinajpur was an especially interesting place in which to examine this question, for, as I showed in my report on Kala-azar, that epidemic took its origin in a very severe outbreak of fever in the Dinajpur and Rangpur districts in the early seventies owing to a succession of very unhealthy years on account of deficient rainfall. The brief description as yet published by Donovan[1] pointed to a close resemblance between his cases and Kala-azar, and he has recently suggested that they may be the same disease. For purposes of searching for this new parasite it is necessary to do a spleen puncture, as they have not yet been found in the peripheral circulation. This little operation is without danger if properly done, but it necessitates being able to examine the cases in a hospital and careful antiseptic precautions. For over a month a careful watch was kept for suitable cases in the Dinajpur in-door dispensary, but no such case presented itself. On discussing the question with Captain Megaw (to whom I am very greatly indebted for much help throughout my investigation both in getting me cases and in helping in the microscopical examination of some of the slides) he informed me that he had seen a number of such cases at one place only, and that was Ranisankail in the north-west part of the district. When at this place on the village enquiry a number of such cases were met with in the villages around, and they came to the dispensary, which was the most popular one in the district, and by means of anæthetising the surface of the skin with an ethyl chloride spray, spleen puncture was readily performed, even in children, in a painless manner and without the slightest difficulty, on the part of the patients, except in so far that some without fever were disappointed at not being submitted to the new treatment. On a subsequent occasion a second series were done at the same dispensary, every case with any considerable enlargement of the spleen and recent fever being taken without any selection, the histories of the cases being also carefully recorded. These cases taken as a whole were exactly those which have always been considered to be "Malarial Cachexia," some of them presenting as great enlargement of the spleen and liver, accompanied by general wasting and darkening of the skin, as seen in typical cases of Kala-azar

[1] Donovan, *Indian Medical Gazette*, December 1903.

or Kala-dukh when they were considered individually. Others of the cases only presented comparatively slight enlargement of the spleen such as invariably results from repeated attacks of malarial fever. Including one case examined later in the Dinajpur hospital, 30 in all were submitted to spleen puncture, and in most of them a slide was also made from the peripheral blood, and examined for malarial parasites, and a differential leucocyte[1] count made. In this way it was expected that it would be possible to get some clear ideas as to the differentiation of the class of cases in which the new parasites were found from the malarial cases. The results obtained can best be shown by tabulating them in groups.

TABLE VII.—CHRONIC MALARIAL FEVERS.

No.	Sex.	Age.	Duration of fever.	Recent fever.	Anæmia.	Darkening of the skin.	Enlargement of the spleen.	Liver edge below ribs.	Wasting.	Malarial parasite.
1	M.	7	3 years...	Slight ...	Slight ...	Very dark	Beyond navel.	Nil	Thin	Mal tert.
2	„	7	2 „ ...	Frequently	Do. ...	Extremely dark	A. S. S.	1″	Do.	Ditto.
3	„	12	2½ „ ...	Every day	Marked ...	Dark ...	To navel	...	Do.	Ditto.
4	„	14	2 „ ...	Ditto ...	Do. ...	Nil ...	Beyond navel.	Nil	Nil	Ditto.
5	„	8	3½ „ ...	Frequently	Very marked	Dark ...	A. S. S.	1″	Thin	Cresents.

A. S. S. equals down to the anterior superior spine of the ilium.

It will be seen that these cases were of a very chronic type of fever, and all showed the malignant tertian variety of malarial parasite and marked splenic enlargement. Nos. 2 and 4 also showed marked increase of the large mononeuclear white corpuscles, namely 14 and 17 per cent., respectively. No. 3 showed 9 per cent. and No. 5 only 6 per cent.

TABLE VIII.—CHRONIC FEVERS SHOWING LOSHMAN-DONOVAN BODIES.

No.	Sex.	Age.	Duration of fever.	Present fever.	Anæmia.	Darkening of the skin.	Enlargement of the spleen.	Liver below ribs.	Wasting.	Leishman-Donovan bodies.
1	F.	4	15 months	Daily ...	Very marked	Dark ...	A. S. S.	1″ ...	Extreme	Numerous.
2	M.	15	1 year	Do. ...	Marked ...	Very dark	Beyond navel.	1″ ...	Ditto..	Scanty.
3	„	25	2 years	Slight ...	Slight ...	Dark ...	4″ ...	Nil...	Slight ...	Numerous
4	„	15	7 months	Daily ...	Do. ...	Do. ...	Beyond navel.	Do.	Extreme	Scanty.
5	„	40	2 years	Do. ...	Do. ...	Nil ...	4″ ...	Do.	Thin ...	Numerous.
6	„	14	1 month	Do. ...	Do. ...	Do. ...	To navel	1″ ...	Nil ...	Scanty.
7	„	8	1 year	Do. ...	Very marked	Do ...	Ditto ...	Nil	Extreme	Do.
8	F.	7	1 month	Do. ...	Marked ...	Dark ...	Beyond navel	½″ ...	Thin ...	Numerous.
9	„	6	1 year	Do. ...	Slight ...	Nil ...	A. S. S.	4″ ...	Extreme	Scanty.
10	M.	8	1 „	Nil ...	Marked ...	Dark ...	Ditto ...	1″ ...	Ditto...	Do.

* Died of pneumonia. Bodies found in spleen, liver and bone marrow *post-mortem*.

[1] Since my return to Calcutta I have been able to find these parasites in still

The table on the previous page shows a very similar class of cases to those in that of the malarial series, and also a very great variation in the duration of the disease. Thus in cases 6 and 8 the fever had only lasted one month and no marked cachexia was present, although the spleen in both cases was very large for such a duration of fever, being down to the navel. In No. 8 the temperature was 100·2 at the time the spleen puncture was performed, and the slides contained the largest number of bodies met with in any case in the Dinajpur district. In both series of cases darkening of the skin was a marked feature of the majority, and in some instances the patients or their relatives volunteered the statement that the skin had become darker recently. In nearly all of both series there was distinct and often extreme wasting, the face and limbs being very thin, and contrasting with the large abdomens, presented the typical picture of the condition always known as "Malarial Cachexia," but this remark is equally applicable to those which showed only malarial parasites as to those which presented the new bodies recently described. In short, these examinations throw no light on the very difficult question of the differentiation of the malarial cases from those which are presumably due to the new bodies, admitting for the present that they are parasites, as they appear to be. It is of course possible that all these chronic cases may be due to the new bodies, and the presence of malarial parasites in some of them was an accidental complication. It appears to be more likely, however, that the new bodies are a form of protozoa very closely allied to the malarial parasites, and producing a very similar train of symptoms, but with a greater tendency to produce rapid cachexial state, and with a greater resistance to the action of quinine in ordinary doses. In view of the above results it is clear that the differentiation of the two forms by purely clinical means apart from spleen puncture will be a matter of extreme difficulty and will require a study of a much larger series of cases than the present one. The fact that one-third of these cases showed the new parasite is sufficient to prove that it is present in a large proportion of these chronic fevers. On the other hand, in no less than half the cases neither malarial parasites nor the new bodies could be found even by spleen puncture, although all but two of the patients gave a history of fever continuing for a long time up to the date of examination, and chiefly occurring at night or in the evening. It is clear, then, that no more can be said than that the new parasite-like bodies can be found by spleen puncture in a number of chronic fever cases with large spleen

larger proportion of this class of cases, nearly every case of so-called "Malarial Cachexia" having shown the new parasites in the spleen, while they could not be found after deaths from other diseases.

in the Dinajpur district, and that no distinction can at present be made out between the symptoms seen in these cases and in those due to repeated attacks of malaria in which malignant tertian parasites were found.[1]

With regard to the nature of the bodies found in the former cases there is little to be said; for in view of the fact that such authorities as Laveran, Ross and Manson are at complete variance as to the classification of them, it is useless to add one more to the opinions already expressed with regard to their nature. I will only say that nothing like a trypanosome was ever seen in any of the cases, either in the peripheral blood or in that drawn direct from the spleen during life. I hope to be able to submit coloured drawings and specimens to high English authorities on protozoa very shortly in the hope that they will be able to throw some light on the question, but in all probability some of the stages of the parasite have still to be discovered. The form most frequently seen is a small oval body slightly longer than it is broad, measuring about one-third the diameter of a red blood corpuscle in its longest axis. It has two nuclei, one of which is small and often rod-shaped and stains deeply, while the other is rounded, considerably larger, but more feebly stained. They are free in the blood from the spleen and in most of the cases are scantily met with, but in exceptional instances, and usually in cases which showed an actual fever at the time the blood was taken, they may be very numerous, a number of them being seen in some fields. In addition to this common form small groups of similar bodies are met with clumped together so as to very closely resemble a quartan sporulating body, some of them being in the act of breaking up. A still earlier stage is sometimes seen in which pairs of unequal sized neuclei are grouped within a single cell, but no separation into the small bodies is yet to be distinguished. These last bodies are somewhat larger than the largest of the simple forms, and appear to be formed by a subdivision of the nuclei of the largest full-grown small forms. I have not been able to detect these bodies in the peripheral circulation by examinations of ordinary blood films, but this would not exclude the possibility of their being present in small numbers there. They may be found within the polynuclear white corpuscles, and be thus undergoing degeneration, which is of interest in connection with the very great reduction of the total leucocytes, and especially of the polynuclears in these chronic fevers which I have previously pointed out.

Kala-dukh and Kala-azar.

In accordance with my instructions to visit the Kala-dukh area of

[1] The differentiation of the continued and remittent fevers of the tropics by the blood changes. Trans. of the *Medical Chir. Soc.*, 1903, and *Lancet*, Volume I, 1903.

Purnea district, I made enquiries from the district authorities as to the parts at present affected by the disease, and was informed by the Civil Surgeon, Captain Hayward, I.M.S., that it was to be found in the north of the Kissenganj subdivision. I wrote to the Subdivisional Officer for information some three weeks before I intended to start for the Purnea district, but did not receive any reply until after my return from a fruitless search for the disease, and then was informed that it had died out of the district. During my visit to the area under the kind guidance of Captain Hayward evidence was obtained of the spread of the disease in a northerly direction, for at Aloobaree it had been present eight years ago, while eight miles further north at Chapra it has disappeared only three years ago. On reaching Thaurganj, 16 miles north-west of the first-named place, search was made for cases in the neighbouring villages which were badly affected by the disease at the time of the enquiry made by Major Harold Brown[1] in 1898, but here we were informed that it had disappeared a year ago, and two persons who had suffered from the disease were shown me, one of which had been free from fever for a year and appeared to be nearly completely recovered from its effects, while the other had had no fever for six months, and but was still thin and his spleen reached nearly to the navel. No cases still suffering from fever could be found, so no spleen punctures could be performed with any hope of finding the new parasite-like bodies.

On the other hand, thanks to the kindness of Dr. Dodds Price of the Nowgong district of Assam (who helped me so materially in my enquiry into the nature of Kala-azar in 1896-97) in very kindly sending me slides made from blood obtained by spleen puncture in seven cases of Kala-azar, I was able to search for the new parasites in these cases. The results are shown in the following table: one slide was spoilt in trying a new fixing agent:—

TABLE IX.—KALA-AZAR CASES.

No.	Duration of disease.	Parasites.
1.	7 months	Numerous.
2.	3 years	Ditto.
3.	2 „ improving	Nil.
4.	5 months	Numerous.
5.	8 months	Scanty.
6.	$2\frac{1}{2}$ years	Ditto.

NOTE.—This observation has since been confirmed in two further series of slides from Kala-azar cases.

[1] Report on Kala-dukh by Major Harold Brown, I.M.S., 1898, and in *Indian Medical Gazette* of 1898.

It will be seen from this table that the new bodies were found in every case except one, which was improving and in which recovery was expected to take place. They were more frequently present in large numbers in this series than in the Dinajpur cases, but no differences in the appearances they presented could be made out in the two series. Since these observations were made a paper by Dr. Bentley, of Assam, has appeared announcing that he has also independently found the Leishman-Donovan bodies in Kala-azar cases, and abandoning the theory he advanced so warmly a little over a year ago that Kala-azar was a severe form of Malta fever.[1]

The importance of these observations lies in the fact which I pointed out several years ago[2] that single cases of the Assam epidemic disease were indistinguishable from cases of ordinary "Malarial Cachexia," so that the discovery that a protozoal parasite (differing from that of malaria and producing the same condition as repeated attacks of malaria causes) is to be found in many cases of "Malarial Cachexia" and in the communicable form of the disease in Assam will fit in with the known facts. So far the new form of parasite has not been found to contain pigment, so that if this is confirmed, then it will be certain that in both the endemic and the epidemic form of the new fever, malaria must be a nearly universal complication, for I showed both in Assam in the case of Kala-azar, and in Calcutta in the case of "Malarial Cachexia,"[3] that melanotic pigment characteristic of malaria is, in my experience, always to be found in the organs *post-mortem* in both series or cases. Possibly it may prove that the new parasites are a secondary infection in patients already infected with malaria, which is so well nigh universal in both Eastern Bengal and Assam, but such points can only be cleared up by further investigations. From the practical point of view the most important inference lies in remembering that quinine in large doses is the only drug which will cure these chronic fevers, although it undoubtedly not infrequently fails in neglected cases. Further, as demonstrated by Dr. Dodds Price, of Nowgong,[4] the drug is undoubtedly an efficient prophylactic against the disease; for while carrying out the segregation measures I

[1] Bentley on Epidemic Malta fever in Assam, *Indian Medical Gazette*, September 1902.

[2] Report on Kala-azar, 1893.

[3] Is malarial cachexia purely malarial? *Indian Medical Gazette*, October 1902.

[4] Note on Kala-azar by Dr. J. Dodds Price. *Indian Medical Gazette*, October 1902.

recommended (which proved eminently successful[1] in getting rid of the infection of coolie lines), he found that his hospital assistants and menials in the Kala-azar camp one after the other contracted and died of the disease. He then took to dosing them regularly with quinine, after which, in the course of several years, he only lost one man, who had become infected before the quinine administration. If it is such a powerful prophylactic it can hardly fail to have curative effects in big doses in early cases of the disease, so that the measures which will be of value in preventing this class of fevers will be the wide distribution of quinine as in malarial fevers.

Varieties and Distribution of Anopheles.

The facts collected bearing on the presence of malarial-bearing mosquitoes in different parts of the district may next be dealt with. A careful study of this part of the question was first made in Dinajpur town, and subsequently the varieties found in different circles in the district were worked out. As Stephens, Christophers and James have shown that the varieties of anopheles present in any district play a very important part in the etiology of malaria, it is necessary to ascertain the proportion of the different kinds as well as the total number of the anopheles present. Thanks to the recently-published book of the two first-named authors, this is not such a difficult task as it was a short time back. In searching for anopheles it is necessary to ascertain both their breeding places and also the numbers actually met with in the houses of the people. The latter was done with the aid of the Municipal Overseer, who rendered great assistance in the matter. In the month of January, when this survey was carried out, the breeding places were limited to the rivers which run past and through the town, and the tanks within it, which are not very many in number. The former include a very sluggish weed-overgrown stream and a canal of a similar nature, which run through the eastern part of the municipal area, while it is bounded on the west side by the river. There are several good brick-lined drains in the town, but most of the roads still have only earth surface ones, which always retain water and form the most important breeding-ground for anopheles in the rainy season, so that the distribution of the different varieties will be very much more widespread at that time than they were at the time of my inquiry.

In all no less than five varieties of anopheles mosquitoes were

[1] Kala-azar successfully eradicated from tea gardens by segregation measures. *British Medical Journal*, September, 1898, and Trans. *Medical Chir. Soc.*, 1899.

actually caught in the houses. That which was by far the most commonly met was A. Fuliginosus, as will be seen from the table below. Next came A. Rossii, although this variety was only present in large numbers in the houses near the tanks in the centre of the town. The next most frequently met with was A. Listoni, and this is probably the most important of all, for the Malaria Commission[1] found it to be associated with a very high prevalence of malaria in the Duars, where it was the most common anopheles met with and the only one which they found to be naturally infected. It has not hitherto been found south of the Jalpaiguri district as far as I know, so its presence throughout all the most malarious parts of Dinajpur is noteworthy, for although only found in small numbers during my visit from January to March, yet there are good reasons for believing that it may be present in much larger numbers in the rainy fever season. In the first place this variety breeds exclusively in running water, so that its breeding-places in the cold dry season are limited to the streams on either side of the town. In the rainy season, however, there will be numerous flowing streams and earth-lined drains which will afford it adequate breeding-grounds throughout the town. Once more in the Punjab Major Adie[2] has shown that although in the dry season A. Fuliginosus is the common anopholes met with, yet in the rainy fever season it is nearly entirely replaced by the A. Culicifacies, which belongs to the same group of small dark malaria carrying mosquitoes as does the A. Listoni met with in Dinajpur. It is probable, then, that this dangerous variety is much more common in the fever than it is in the dry season. The other two varieties met with in the houses are of much less importance, for they belong to the wild group, which breed in swampy places and rarely enter inhabited houses, while they have never yet been found to be carrying malaria under natural conditions. These are the A. Barbirostris and A. Sinensis, the latter having only once been found in the houses, although their larvæ were met with not very rarely in weed-grown streams and canals, especially to the east of Dinajpur.

With regard to the breeding-places of these varieties, it may be said that A. Fuliginosus was met with in both the streams and also in weed-grown tanks. A. Rossii in the tanks most commonly, A. Listoni chiefly in the sandy river to the west of the town, especially close to the grassy banks, but they must also have been breeding in the more sluggish stream to the east, as they were caught in the houses of that part of the town. The other two were found in the weedy streams as

[1] Reports of the Malaria Commission of the Royal Society.

[2] Adie, *Indian Medical Gazette*, 1903.

already mentioned. While making collections in the houses in different parts of the town striking differences in the local distribution were met with. Thus, while A. Rossii abounded in the central tank strewn portion, and A. Fuliginosus and A. Listoni near the streams on either side of the town, there was a dry zone between the central and the western portions in which a very careful search failed to reveal a single anophele. Moreover, the more intelligent inhabitants of the riverine portion where most A. Listoni were found were convinced that this was the most malarious portion of the town in the rainy season, although this was not evident at the time of my visit in the dry healthy season.

Turning next to the distribution of the anopheles in the district circles, which is illustrated in table X, we find the A. Fuliginosus to have been the common variety in all parts of the district in the cold season. A. Rossii and A. Sinensis were seldom found except in the town of Dinajpur, and A. Barbirostris was only occasionally met with. With regard to the malarial carrying A. Listoni it is worthy of note that it was not met with in Porsa at the extreme south of the district, this being also the least feverish part, nor could its larvæ be found in the river, which appeared to present favourable conditions for its presence. In Churaman also, which is also comparatively little feverish, I failed to find this variety. It would not be wise to lay too much stress on this point as the distribution of this mosquito might be much more extensive in the malarial season.

TABLE X.—VARIETIES FOUND IN THE HOUSES.

	Dinajpur.	Bâlughat.	Porsa.	Churaman.	Ranisankail.	Total.
A. Fuliginosus ...	178	51	103	106	108	546
A. Rossii	39	5	...	...	...	44
A. Litsoni... ...	6	4	...	...	6	16
A. Barbirostris ...	3	1	...	1	8	8
A. Sinensis ...	2	...	...	...	...	2
Total ...	228	61	103	107	117	616

Dissection of Anopheles.—In addition to ascertaining the varieties of anopheles present in the houses it is also necessary to find out by means of dissections and microscopical examinations of the salivary glands for sporozoits which varieties are actually carrying infection. For this purpose 138 anopheles caught in the houses in Dinajpur were examined for sporozoits, but none were found. Nearly all of them were A. Fuliginosus, which was never found to be naturally infected by the

Malarial Commission, although they showed that it can be artificially infected. More recently Major Adie[1] in the Punjab found one of these anopheles to contain sporozoits resembling those of human malaria, but it is clear that it is not a common carrier of the disease. Unfortunately very few A. Listoni could be obtained for dissection, and no sporozoits were found in them. This is not surprising, for these dissections were carried out in the cold month of January, and it is well known that a certain temperature is necessary to allow of the development of the malarial parasite in mosquitoes. In a previous paper I showed[2] that the number of cases of malarial fever fell off very rapidly in a suburb of Calcutta as soon as the minimum temperature fell to 60F., doubtless for the reason just mentioned, and as the minimum temperature in Dinajpur in January was much below that point it is not surprising that no sporozoits could be found. I had hoped to be able to ascertain if the A. Listoni was infected when the weather had become warmer again, and just before leaving Dinajpur in the middle of March, I tried to collect the necessary mosquitoes, but they were still as scanty as earlier in the year, so I was not able to obtain them in sufficient numbers for dissection. This point can only be settled in the rainy season, but as Dinajpur is close to Jalpaiguri, where the Malaria Commission found the A. Listoni to be infected later in the year than the time of my inquiry, there can be little doubt that this is the variety which is mainly responsible for the prevalence of malaria in Dinajpur and the neighbouring districts, for I also found this species in small numbers in the northwest corner of the Purnea district.

The Possibility of Destroying Anopheles in Lower Bengal.

It will be convenient in this place to discuss the practicability of attempting in Lower Bengal to destroy those anopheles which carry the infection of malaria as a method of malarial prophylaxis. It will be clear from what has been written above that it would be an utter waste of money and labour to attempt to destroy all the different kinds of anopheles, when only one, or possibly two, of them, have been found to carry the disease in nature. Thus, it is now generally admitted from dissections of many hundred A. Rossii that these are never found to be naturally infected, although they can be infected by artificial means, and are thus theoretically capable of conveying the disease. For the same reason, we may exclude from our consideration the swamp species

[1] Adie, *Indian Medical Gazette*, 1903.

[2] The seasonal prevalence of anopheles and malarial fever in Lower Bengal and the practical application of the mosquito theory. *Journal of Hygiene*, October 1901.

which very rarely enter houses, and have also not been yet found to be naturally infected. This leaves us with only the A. Fuliginosus and A. Listoni, the former of which has only once been found naturally infected in the Punjab, while there it almost disappears before the fever season begins. If it proves to have a similar seasonal distribution in Bengal it may also be excluded from consideration as not being of any material importance in the etiology of malaria. Some three years ago a plan for destroying anopheles mosquitoes in Calcutta was initiated under the idea that they only bred in small pools which could be easily dealt with, as suggested by Major Ross. At that time I made a careful search for the breeding-places of anopheles month by month for more than a year in a selected area in a suburb of Calcutta, with the result that I found them[2] to be breeding in enormous numbers in nearly all the tanks during the hot-weather months, that is, at the time of the minimal malarial season. On the other hand, they were much fewer in number during the rainy malarious time, but their distribution was then different, the tanks being free from them, while the chief breeding-places were small pools and more especially the shallow uneven earth drains on each side of every road. Moreover, in these roadside drains varieties of anopheles which can carry malaria were found, whereas those which had swarmed in the tanks at an earlier period were all A. Rossii, which we now know [1] are harmless as far as the spreading of malaria is concerned. The measures which were being taken for destroying the A. Rossii in the small pools and tanks, then, were only money thrown away as far as malarial prophylaxis was concerned. This example is mentioned to show that great circumspection is required in recommending measures for destroying anopheles in Lower Bengal.

A still more instructive example is that of the measures which have been carried out under the directions of members of the Malaria Commission during the last two years at great expense to test the practicability of destroying anopheles in a portion of the very malarious cantonment of Mian Mir,[2] the results of which have recently appeared. In this place the chief breeding-ground of the malaria-bearing variety was the irrigation canals which traverse the cantonment. The results of these operations will be familiar to the Sanitary authorities, but briefly it may be said that the elaborate measures carried out persistently for two years resulted in only a slight diminution of the number of anopheles in the houses of the treated area. On the other hand, much good was obtained by prophylactic issue of quinine, and still more

[1] Reports of the Malaria Commission of the Royal Society.

[2] Report on anti-malarial measures at Mian Mir. Scientific Memoirs, New Series, No. 6, by S. P. James.

marked effects were got by treating all the children in a syce line in this way, malaria being nearly absent from both the children and the adults. Further, the moving of some syces from their old lines near the canals to one-half a mile or more from them resulted in an entire absence of both the anopheles and of malaria fever among them. That the total destruction of the malaria-bearing mosquitoes will prevent the fever is certain, but experience in India has proved that it is only very exceptionally favourable conditions that this measure is practical, while it must be continued indefinitely. Such conditions were met with at Ismalia, where rain falls on but very few days of the year, and certain swamps and pools were easily permanently filled up. Here the resulting reduction of malaria has been most marked, but to attempt to apply this method to the totally different conditions of Lower Bengal and to expect similar results would be utter folly.

In view of the above facts, let us return to the conditions met with at Dinajpur. Here we have the malaria-bearing A. Listoni breeding throughout the course of two streams one on either side of the town, and probably also in the rainy season in the numerous subsidiary streams which flow into the main one during that time. To attempt to destroy the larvæ in these rivers throughout the rainy season is obviously utterly impracticable. Something may be done by steadily extending year by year the brick-lined drains through the main streets, so as to do away with the stagnant earth-lined drains, the bottoms of which it is almost impossible to keep sufficiently level to prevent water standing in them. Further within the municipal limits the formation of borrel pits during road-making by the Public Works Department should not be allowed, as at present, for they form excellent breeding grounds in the rainy season. These measures are only applicable to the town itself, and do not touch even the smallest proportion of the total population of the district among whom it is quite clear, then, that some other measure than mosquito destruction must be relied on.

The Village Distribution of Quinine.

Where it is found impossible to destroy the intermediate host of the malarial parasite, namely, the malaria-carrying varieties of anopheles, the only other practical method of malaria prophylaxis is the destruction of the parasites during their cycle in the human subject. This can only be done by efficient doses of quinine, so that the problem resolved itself into one of devising a practical scheme of village distribution of quinine. It has already been mentioned that the administration of quinine regularly as a prophylactic to the children of a syce line in Mian Mir not only saved nearly the whole of them from

malaria, but was also effective in preventing the infection of any of the adults in the same lines, although these latter took no quinine whatever, because adults are infected by mosquitoes which have first derived the infection from children as a rule. I have also shown in an earlier part of this report that the main death-rate from acute malaria is among children during the few months of the rainy season and immediately afterwards. If these could be adequately treated with quinine as soon as they developed fever (for its prophylactic distribution to children in villages is as yet beyond the region of practical policy), not only would the main source of death-rate from malaria be stopped, but at the same time there would be much less infection among adults, and fever deaths from chronic malaria and from other diseases such as pneumonia, dysentery and phthisis, which so often attack those debilitated by previous malaria.

In discussing this important question we must first consider how far the present agencies for the distribution of quinine meet the necessities of the case. They are the dispensaries, private practitioners and the post-offices. That the dispensaries effect great good by the treatment of fevers with quinine was abundantly evident throughout my inquiry, for in every place where there was a flourishing dispensary the spleen-rate was considerably lower than it was in the neighbouring villages, the differences being much greater than could be accounted for by the position of the dispensary village on a slightly higher and more healthy site in some instances. The difference was most marked among the children of the more intelligent classes, for it was particularly marked among the children attending the larger schools. The most striking example met with was that of a school at Churaman which stood next to the dispensary, for among 31 children only two had any enlargement of the organ, or 6 per cent., by far the lowest rate met with in the district. In this instance I ascertained from both the School Master and the Hospital Assistant that the boys were regularly sent to the dispensary from the school when they were found to be getting fever. In Balughat a very similar state of affairs was found. As it was not uncommon for about one-third of the children attending the school to be down with fever at one time in the rainy season, it is clear that they must, most of them, have been treated during the year. The Civil Surgeon, Captain Megaw, I.M.S., had been struck by this fact before my arrival in the district, and my own experience amply confirms his. The range of such a dispensary unfortunately is seldom more than two or three miles, or five at the outside, so that the quinine distribution of seven dispensaries among the one-and-a-half million persons in the district of Dinajpur is scarcely more than a grain in an extensive sandy

desert, and any practical increase can only be a matter of very slow growth. Private practitioners abound in Dinajpur itself, and although a large proportion of them profess homœopathy, yet they doubtless do some good in the treatment of fevers. In the district itself, however, they are almost a negligible quantity.

Turning next to the post-office distribution I found that there are but 40 post-offices to very nearly 4,000 square miles, or one to every 100 square miles. Further, seven of these are in the same places as a dispensary is situated. During 1903 throughout the whole district only 8,064 packets of the drug were sold among 1,500,000 people, although my enquiries showed that the great majority of the population suffer from fever repeatedly in each year. These figures will suffice to bring home the fact that the infinite majority of the population of Dinajpur, and doubtless of all other malarious districts of Bengal, are beyond the reach of the one drug which will save their lives when attacked by malaria, to say nothing of an infinite amount of suffering and loss, while thousands of children die yearly, whose lives could be saved with absolute certainty if quinine were readily available for their treatment.

My object in laying stress on this fact, which is only too well known, is because my enquiries have led me to believe that something can and ought to be done to remedy this cruel loss of life from malaria, specially among children. Some of the dispensaries do not do all they might, the stock of quinine supplied being often utterly inadequate, while it is occasionlly allowed to run perilously low, with the result that it is not dispensed when it should be, as in one case only six drachms were in hand at the time of my visit, but this is a matter for administrative care. Perhaps more quinine would be used if the good an outdoor dispensary does was measured by the amount of quinine dispensed rather than by the number of petty operations performed, but still any improvement thus effected would only touch the fringe of the question. What is really wanted is some system of distribution of the drug in every village. I have discussed with the district postal authorities the possibility of a more extended distribution of the drug through the postal peons on their visits to the villages, and I am of the opinion that something might be done in this direction by giving a small commission to those agents in order to stimulate the sale of the pice packets. Still it appears that many small villages and hamlets may not be visited for weeks at a time by the postman, especially during the rainy fever season when communication is at its worst, and some new agency actually residing in the villages themselves is necessary if any real success is to be obtained. Such an agent should be somewhat more intelligent than the village chaukidar, whose burden is already quite

as much as he can bear, and should also, if possible, be in close touch with the children, whom it is particually desired to reach. Such a man is the village schoolmaster, for a primary school is now to be found in nearly every village, or group of villages, and it would be to the advantage of the master to get his pupils to take quinine whenever they get fever, for he is interested in keeping up the figures of his attendance-roll, which is greatly affected by absence on account of malarial fever in the rains. I am informed that the masters of the primary schools get only about Rs. 10 a month, so they would not be above accepting a small commission on their sales, which would encourage them to do their best in the matter. The headman of the village might in some cases also be enlisted among the dispensers of quinine. I have spoken to many intelligent natives, both official and unofficial, about this plan, and they have all approved of its being given a trial. Whether it would be advisable to supply packets free to the schools or to sell them below cost-price at first in the most malarious tracts is rather difficult to decide, as it might lead to purchase for the sake of selling again at a higher price, while difficulties might arise when the drug had become sufficiently popularised to make it advisable to raise the price to its cost-point. I think, however, some packets might be supplied free to the schools. This is a matter for the sanitary and administrative authorities to settle, but that some system of village distribution of quinine, among the children more especially, is an urgent necessity if the heavy death-rate from malarial and chronic cachexial fevers is to be lessened, is quite certain, for it is the only practical method of prophylaxis in the swampy mosquito-swarming tracts of Lower Bengal.